

# THE WEATHER AND CIRCULATION OF AUGUST 1968

## Sharp Contrasts in Temperature and an Unusually Strong Summer Index Cycle

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### 1. INTRODUCTION

August 1968 was extremely cool and wet in the western United States while the East was generally hot and dry. There was considerable severe weather in the area separating this temperature contrast. The circulation was highlighted by an index cycle which was accompanied by marked changes in temperature. No tropical storms seriously threatened the Atlantic or Gulf Coasts.

### 2. MEAN CIRCULATION

The average circulation at 700 mb. for August 1968 consisted of rather fast westerly flow over the western

portion of the Northern Hemisphere. The zonal index, computed between lat. 55°N. and 35°N. in this area, has averaged above normal since June. Fastest wind speeds, relative to normal, continued in the Pacific where they were as much as 15 m.p.s. The axis of maximum wind here was displaced slightly south of normal, largely in response to a strong blocking ridge centered over Alaska (fig. 1) with 700-mb. heights 80 m. above normal (fig. 2).

Rapid progression occurred in the Pacific from July [1] to August as the trough which had been over Kamchatka and off the east coast of Japan moved to the mid-Pacific. At the same time the trough near 145°W. in July moved to the west coast of North America in August as the

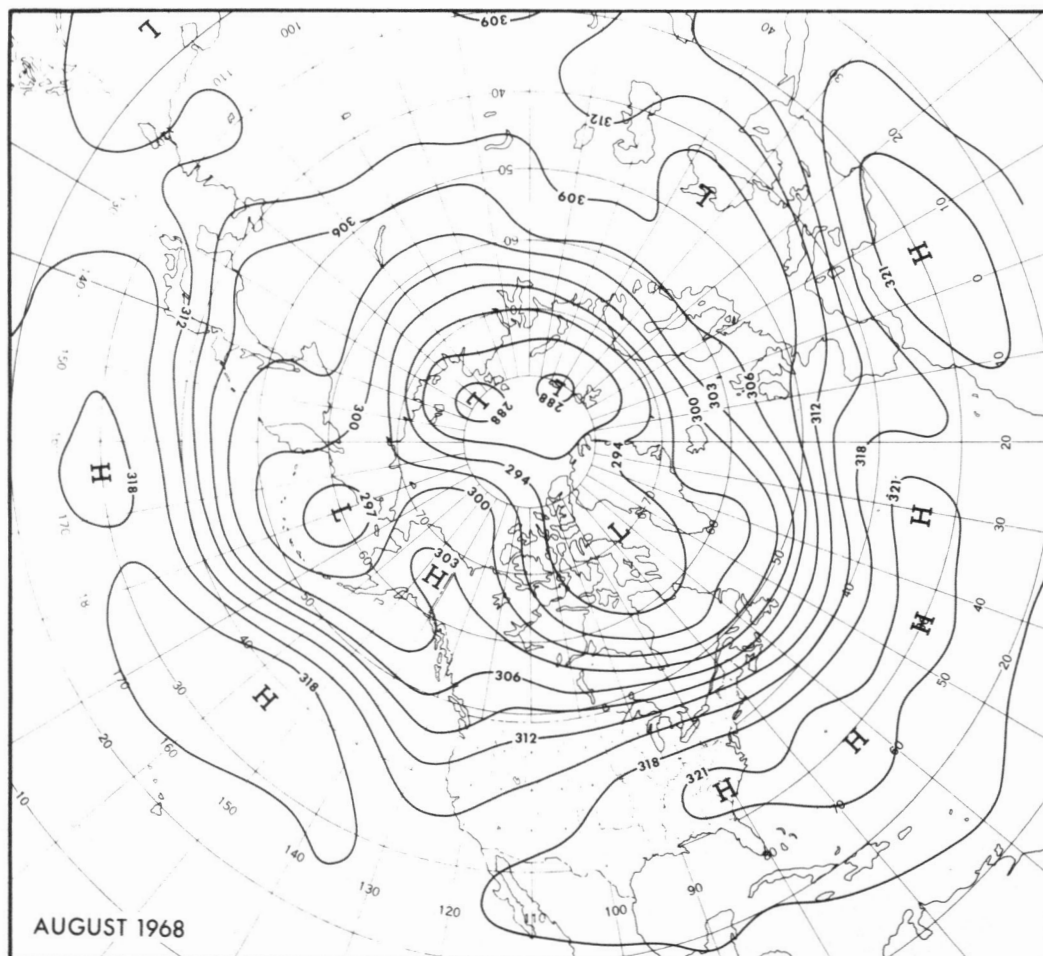


FIGURE 1.—Mean 700-mb. contours (decimeters) for August 1968.

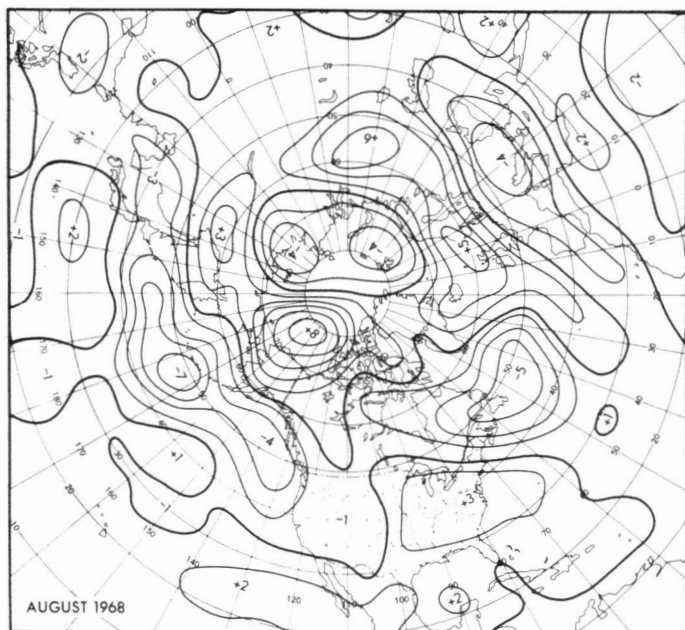


FIGURE 2.—Departure from normal of mean 700-mb. height (decimeters) for August 1968.

circulation changed from a two cyclonic cell pattern to one cell centered in the Bering Sea (fig. 1, 2).

With the establishment of the trough along the Pacific Coast, 700-mb. heights fell sharply over western United States and southwest Canada as the stronger than normal ridge in July was replaced in August by cyclonic flow and negative height anomalies. This favored development of the ridge over the Central States and Southeast (fig. 1, 2). As in July, the ridge over Alaska contributed to a deep mean Low over eastern Canada. The Low and associated trough moved eastward from July to August, with the middle latitude portion of the trough advancing from the Great Lakes to the western Atlantic. These month-to-month circulation changes led to a pronounced confluence zone from the Great Lakes to the Northeast. While confluence here is characteristic of summer circulations, it was particularly strong this August as indicated by 700-mb. wind speeds of 6 m.p.s. above normal over New England (not shown).

Spread of blocking from the northeast Atlantic to Greenland and Canada, particularly during the last half of the month, contributed to deepening of the trough in the Atlantic where heights were 50 m. below normal east of Newfoundland. Blocking dominated Europe and western Asia where heights were above normal across northern latitudes and below normal to the south (fig. 2). Both branches of the normally split westerlies over Europe were displaced north of their usual positions by blocking, with the southern branch over the Mediterranean being the strongest. The circulation on the Asiatic side of the Pole consisted of two deeper than normal cyclonic cells.

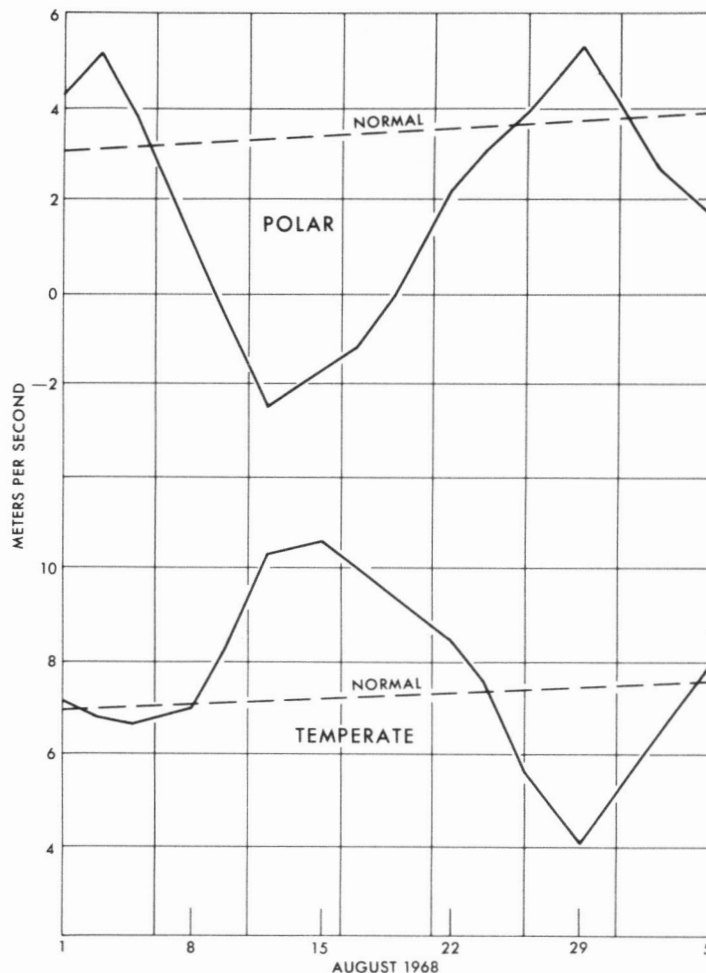


FIGURE 3.—Variation of 5-day average wind speed (zonal index, m.p.s.) at 700 mb. for the western half of the Northern Hemisphere, 70°-55°N. and 55°-35°N. during August 1968. Solid lines connect values at middle of 5-day periods.

Since high latitude blocking was such a prominent feature of the August circulation, it is not surprising that an index cycle occurred at the same time. This cycle, which lasted approximately 4 weeks, was well defined as shown in figure 3 by the curves of 5-day mean polar and temperate latitude zonal indices. The temperate westerlies reached their greatest strength at midmonth, fell rapidly to a minimum on the 29th, and thereafter began to recover. As is commonly observed, the polar westerlies varied oppositely to the temperate westerlies and near midmonth they became easterlies as strong blocking Highs were observed over Greenland and north of Alaska (fig. 8A). Weekly latitudinal variations in 5-day mean west wind speed are shown by the profiles in figure 4. Note that during the last week the belt of maximum westerlies was at 63°N., far north of its usual position.

### 3. TEMPERATURE

Establishment of a trough along the Pacific Coast and lowering of 700-mb. heights to below normal over the

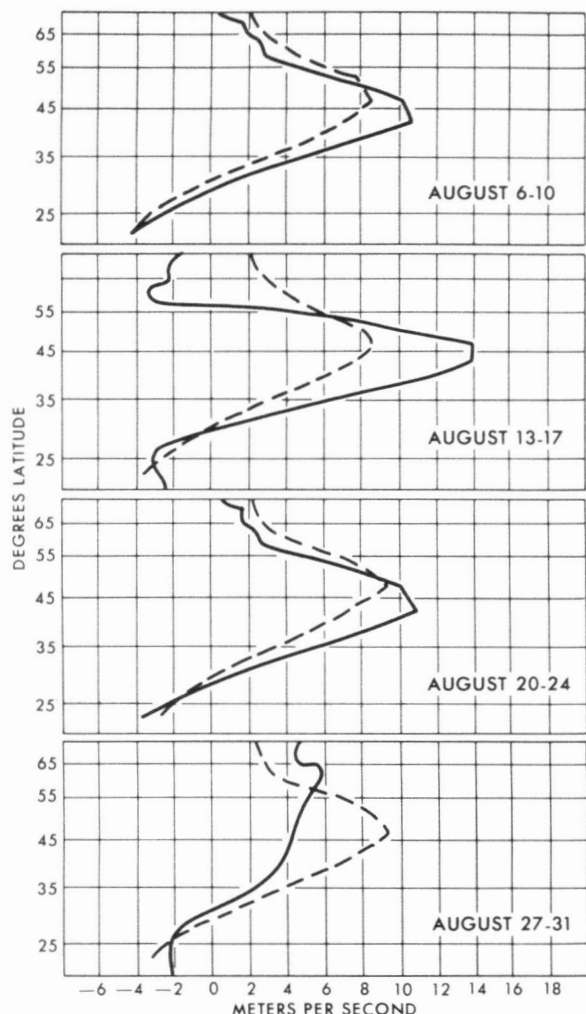


FIGURE 4.—Five-day mean zonal wind speed profiles (m.p.s.) for the western half of the Northern Hemisphere, with normal dashed, for August 1968.

West was accompanied by marked cooling throughout much of the Rocky Mountains and West Coast States. Temperatures averaged below normal in most areas west of the Mississippi River with departures of 4° to 6°F. in the Great Basin and Rocky Mountain States (fig. 5). Most stations from the western high plains to the interior of the Pacific Coast States were in the “much below” category. This represents a four-class change in temperature for many stations in the Great Basin and Northwest from the “much above” class observed in July [1]. This was the coolest August of record at a number of cities, including Pocatello, Idaho; Casper, Wyo.; Salt Lake City, Utah; Grand Junction, Colo.; and Flagstaff, Ariz.

Other regions of below normal temperature were the Upper Lakes Region and the Northeast where departures were mostly 2° to 4°F. This area was north of the confluence zone and cool conditions here were associated mostly with high pressure systems which moved southward from western Canada.

Above normal temperatures were confined primarily to States east of the Mississippi that were beneath the

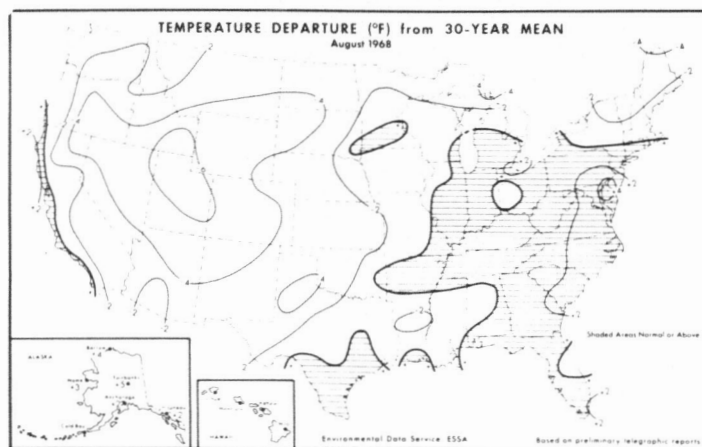


FIGURE 5.—Departure from normal of average surface temperature (°F.) for August 1968 (from [2]).

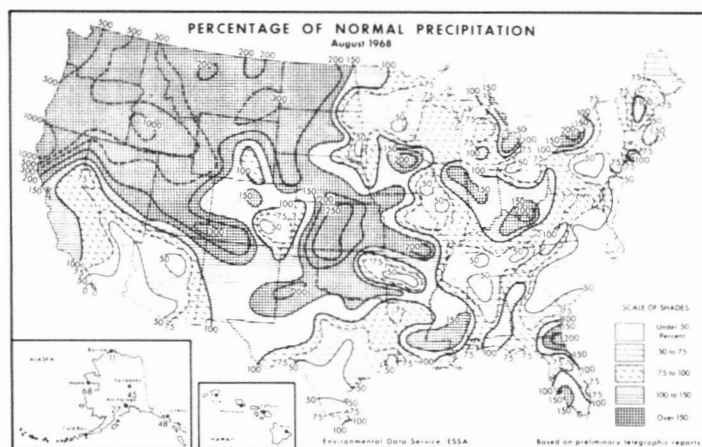


FIGURE 6.—Percentage of normal precipitation for August 1968 (from [2]).

stronger than normal ridge and south of the confluence zone (fig. 1, 2, 5). Temperatures were in the “much above” category in the Middle and South Atlantic Coastal Plain. Baltimore, Md., reported that the mean temperature and number of days (20) with 90°F. or higher were new August records. This was the second warmest August of record at Norfolk, Va.; at Wilmington, N.C., a new mean maximum temperature record was established. In addition, the latter city also set daily maximum temperature records on 7 days. Another notable August record was set at Charleston, S.C., with 21 days of 90°F. or higher.

#### 4. PRECIPITATION

In marked contrast to the dry conditions of July [1], much of the West was unusually wet in August. Precipitation totals ranged up to ten times normal in some places (fig. 6). At many stations in the Northwest, as shown in table 1, some with records dating to 1871, this was the wettest August ever observed. Numerous other places had near-record totals. Wet weather here was related to the deep trough along the coast and associated

TABLE 1.—Record August precipitation amounts observed in 1968

Station	Total precipitation (in.)	Departure from normal (in.)
Yakima, Wash.....	1.71	+1.51
Stampede Pass, Wash.....	7.17	+5.13
Olympia, Wash.....	5.45	+4.56
Portland, Oreg.....	4.25	+3.56
Sexton Summit, Oreg.....	2.42	+2.17
Eugene, Oreg.....	5.79	+5.39
Eureka, Calif.....	1.98	+1.88
Boise, Idaho.....	2.37	+2.21
Pocatello, Idaho.....	3.98	+3.43
Sheridan, Wyo.....	3.02	+2.12
Salt Lake City, Utah.....	3.66	+2.79

primarily with storm systems and fronts moving into the West from the Gulf of Alaska. As a result of cool wet conditions, fire danger in the Far West was generally low in August compared with the high fire danger which prevailed during July.

An exception to the wet weather in the West was the Far Southwest where stronger than normal westerly flow, by cutting off the usual summer tropical moist tongue, did not favor appreciable precipitation (fig. 2, 6). Winslow, Ariz., with only 0.15 in., had its driest August. Another dry area was southern Texas where some areas had less than half their normal rainfall.

Precipitation amounts from the Mississippi Valley to the Atlantic Coast, and beneath the stronger than normal ridge, were mostly less than normal. The driest area was east of the Appalachians in the Middle and South Atlantic Coast States where amounts were less than one-half normal. Easterly wave activity was responsible for much of the precipitation in the Gulf Coast Region where the average circulation for the month had a stronger than normal easterly component (fig. 1, 2). Here, rainfall amounts were about normal, but were more than twice normal in Jacksonville, Fla., where most of the month's rainfall of 16.24 in. fell in connection with a tropical depression at the end of the month.

### 5. WEEKLY VARIABILITY OF WEATHER AND CIRCULATION

The index cycle in the Western Hemisphere during August was accompanied by rather pronounced changes in the weather and circulation over the United States. These changes are described by use of weekly patterns of temperature anomaly and total precipitation with the appropriate 5-day mean 700-mb. circulations (fig. 7-10).

#### AUGUST 5-11

During the last 2 days of July and the first 2 days of August a cold high pressure area moved across the Northern Plains and brought sharp cooling to the Upper Plains and most of the Rocky Mountain States. Daily minimum temperature records were reported from Casper, Wyo., Sioux City, Iowa, and Rochester, Minn., on the 1st.

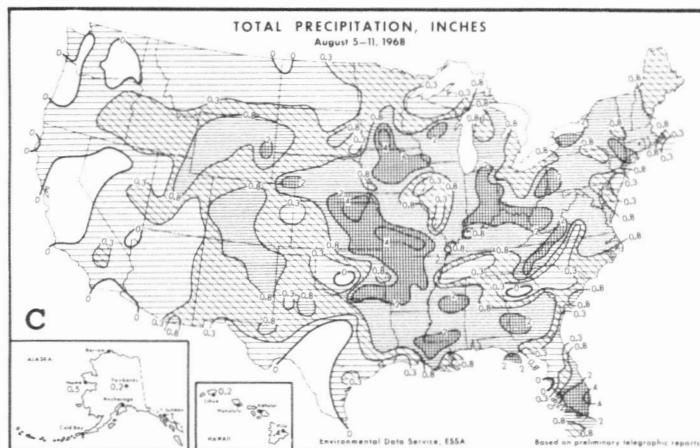
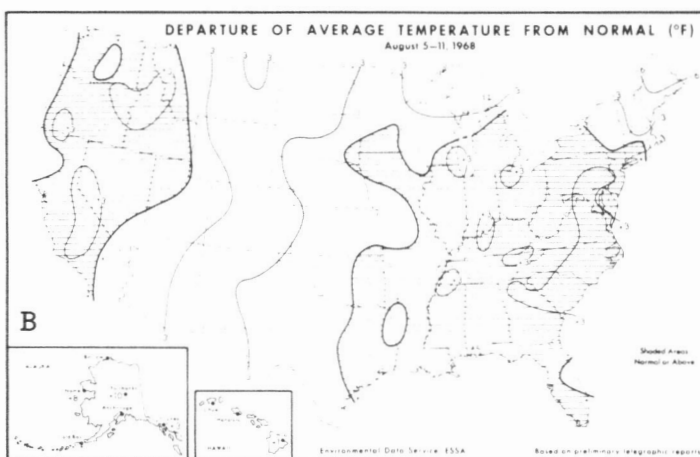
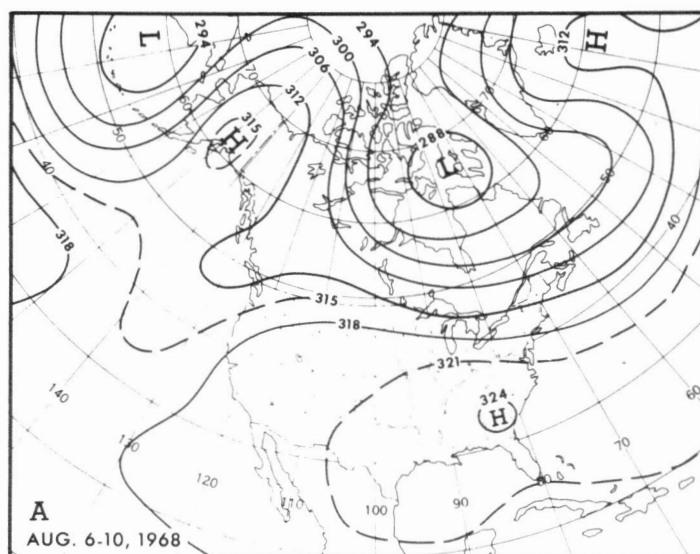


FIGURE 7.—(A) Mean 700-mb. contours (decimeters) for Aug. 6-10, 1968; (B) departure of average surface temperature from normal (°F.), and (C) total precipitation (in.) for week of Aug. 5-11, 1968 (from [2]).

This cool air warmed considerably as it moved eastward and temperatures in the East Coast States remained above normal. A warming trend followed as a trough became established off the West Coast, thus favoring the stronger



than normal ridge that extended from the Northern Plains to the Southeast (fig. 7A). Except for northern New England, 700-mb. heights were above normal over the entire Country during the first week. Even so, temperatures averaged below normal through most of the Great Plains and eastern Rocky Mountain States (fig. 7B). A strong cold front moving slowly southward from Canada was responsible for much of the coolness. The slow movement of the front was due to the strong ridge over the Northern Plains. Below normal temperatures in the Far Southwest were related to cloudiness and precipitation associated with a weak upper Low.

Except for New England and the Upper Lakes Region, hot, humid weather prevailed elsewhere over the eastern half of the Nation for most of the week. The cold front from the West, however, moved off the Atlantic Coast over the weekend bringing relief from the hot, sticky conditions.

Precipitation was rather scattered over the Nation with light amounts, or none, in the Far West and southern Texas (fig. 7C). Much of the precipitation was associated with the slow-moving cold front and fell as showers in severe thunderstorms. One such storm struck Huron, S. Dak., on the 7th accompanied by local flooding and wind gusts to 115 m.p.h. Heaviest rains of 4 to 5 in. fell late in the week in parts of the Central Plains and Middle Mississippi Valley. Shower activity also developed in the hot, humid air south of the front.

#### AUGUST 12-18

Progression of the principal long wave features occurred from the first to the second week as the temperate westerlies reached their greatest strength at midmonth (fig. 3, 4). Blocking Highs, over Alaska and the Atlantic, moved northward as the circulation over the oceans changed from meridional to zonal (fig. 7A, 8A). This evolution resulted in a broad band of 700-mb. negative height anomaly at middle latitudes around the Western Hemisphere, and also into Europe and the western Pacific (not shown).

Advance of the eastern Pacific trough into the West brought an abrupt end to the warm, relatively dry conditions there. Cooling began early in the week with no appreciable warming thereafter as temperatures for the period averaged well below normal (fig. 8B). Greatest departures ranged from 9° to 12°F. in the Northern Plains and Central Rocky Mountain States. Numerous daily minimum temperature records were established as the cold air became firmly entrenched. One such record was the 37°F. on the 14th at Bismarck, N. Dak., where the average temperature for the day was 20°F. below normal. The Great Lakes area and the Northeast were also cool as northerly flow over central Canada transported polar air masses into these areas. At Sault Ste. Marie, Mich., 35°F. on the 15th was a daily low temperature record. A slight weakening of the ridge over the Southeast brought slightly lower temperatures to that area, but averages for the week remained above normal.

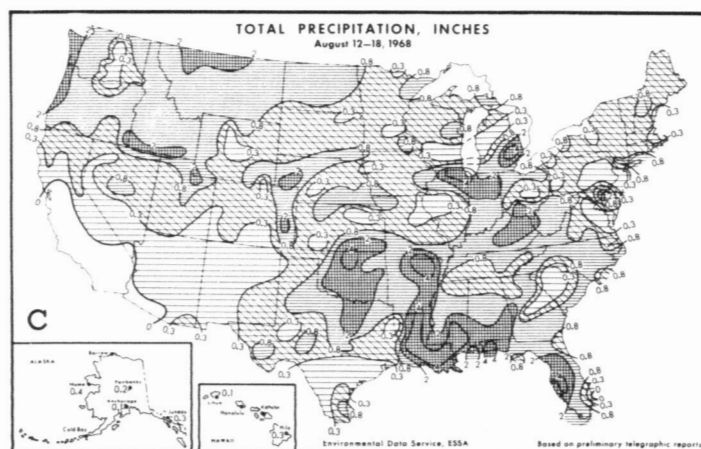
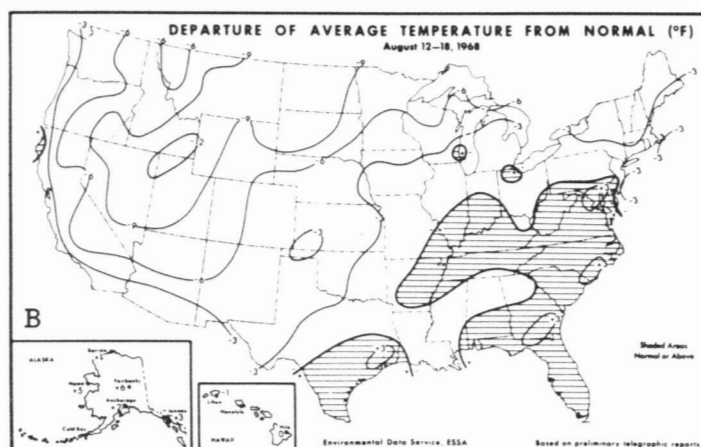
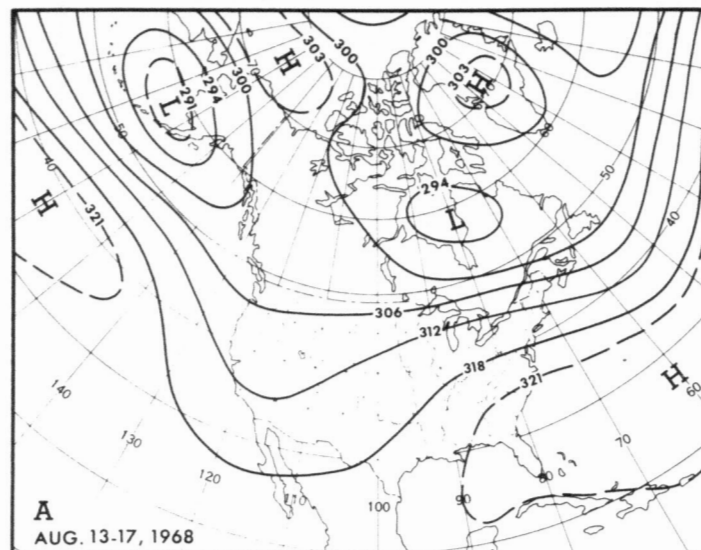


FIGURE 8.—Same as figure 7, except (A) for Aug. 13-17, 1968; (B) and (C) for week of Aug. 12-18, 1968 (from [2]).

Heavy rains accompanied the trough in the Northwest with amounts generally from 1 to more than 2 in. in some places (fig. 8C). In some mountain areas this precipitation fell as snow. An unusual 20-in. fall was reported near the summit of Mt. Lassen and up to 8 in. fell in the

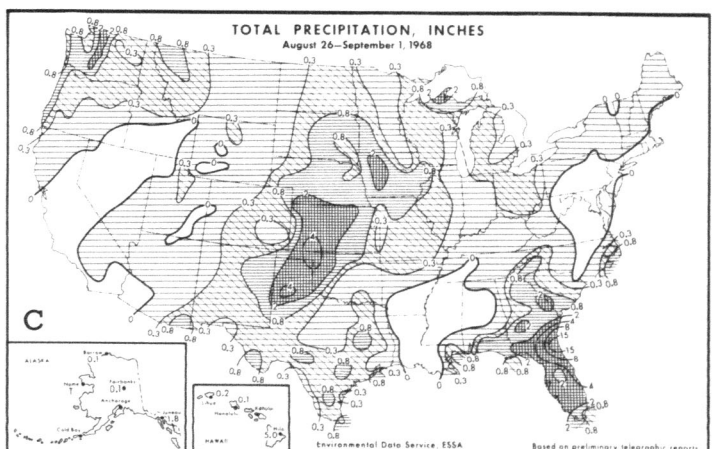
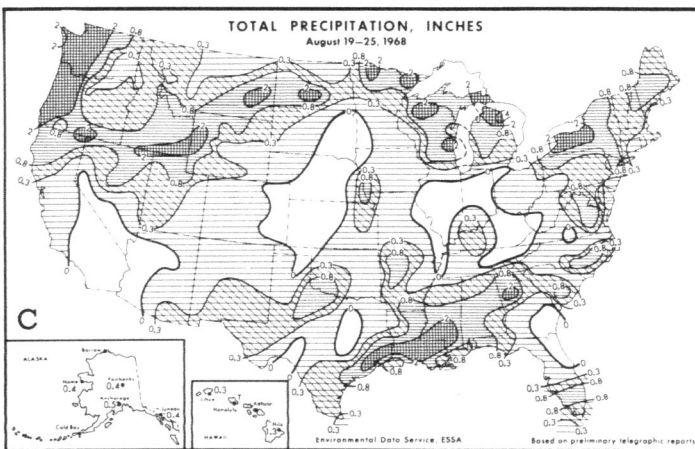
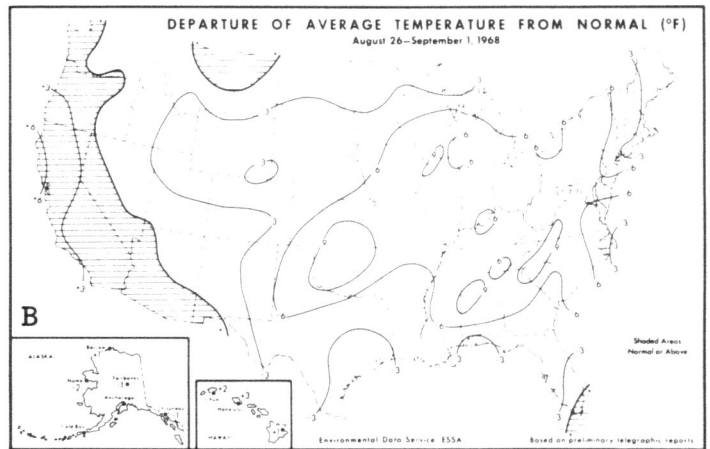
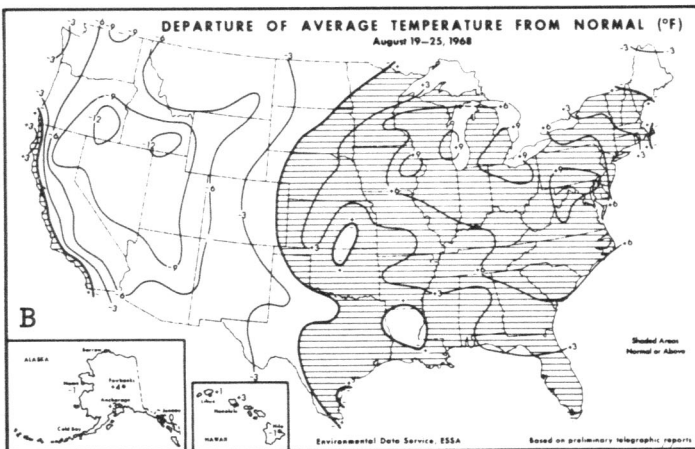
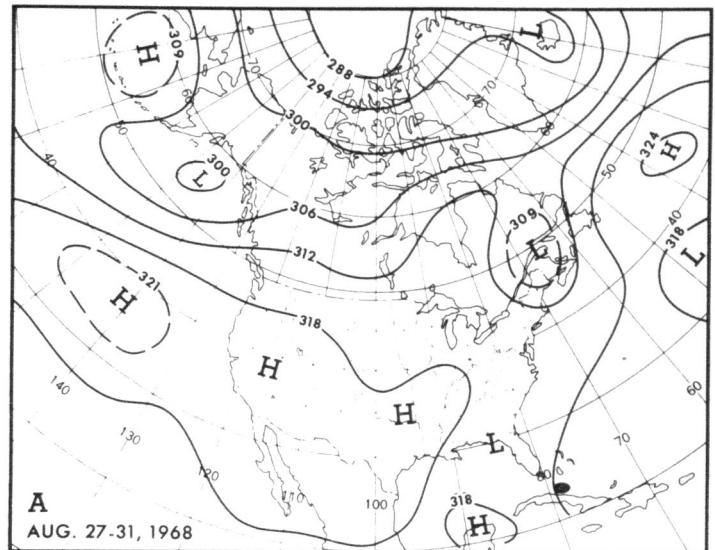
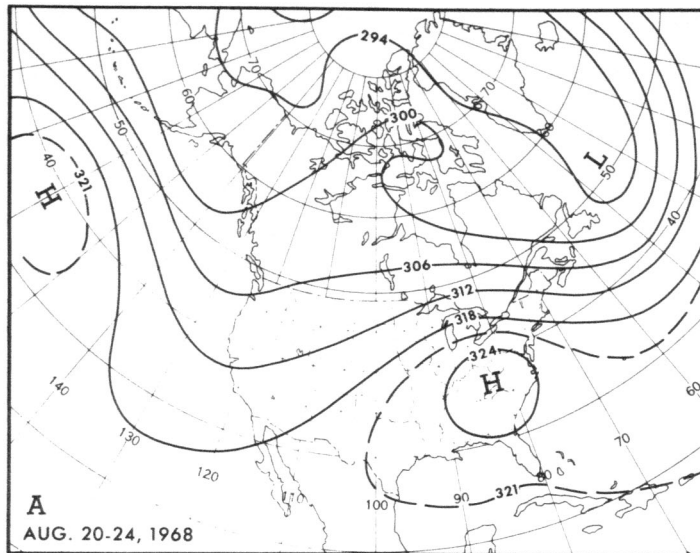


FIGURE 9.—Same as figure 7, except (A) for Aug. 20-24, 1968; (B) and (C) for week of Aug. 19-25, 1968 (from [2]).

FIGURE 10.—Same as figure 7, except (A) for Aug. 27-31, 1968; (B) and (C) for week of Aug. 26-Sept. 1, 1968 (from [2]).

Bighorn Mountains of Wyoming on the 18th. Snow also covered higher elevations of the mountains in northeast Nevada. As in the first week the distribution of precipitation elsewhere over the Nation was rather chaotic and very typical of summer. Convective shower activity

continued in the tropical air over the South, while to the north much of the rainfall was related to a storm system and its trailing fronts that moved eastward near latitude 50°N. Some of the rainfall along the South Atlantic Coast was due to tropical storm Dolly. This storm moved

northeastward off the coast on the 10th and 11th and gradually intensified to a minimal hurricane on the 12th about 300 mi. east of Cape Hatteras. Once imbedded in the fast westerlies Dolly moved rapidly eastward.

#### AUGUST 19-25

Amplification set in during the third week as the highly unstable circulation of the previous week began to break down. The principal Pacific anticyclone remained stationary, but strengthened northward, thus helping to effect retrogression of the Far West trough to a position along the coast (fig. 8A, 9A). Blocking spread from Greenland to northern Canada where the ridge merged with a strong upper High over the Southeast. The positive 700-mb. height anomaly center with this High had a maximum value of 75 m. over the Ohio Valley.

Below normal temperatures persisted in the West (fig. 9B) as the flow there remained cyclonic and upper heights continued to be below normal. Warming did occur, however, from the Great Plains to the Atlantic Coast in response to the strong upper anticyclone. Except for northern New England, temperatures were well above normal in most areas, as much as 9°F. in parts of the Great Lakes Region and Middle Atlantic States. The combination of high temperature and high humidity made this week one of the most uncomfortable of summer. Many heat records were established including numerous stations with daily maximum temperature records. Among these were nearly all stations in Virginia, the Carolinas, and eastern Tennessee on most days from the 22d through the 25th. Columbia, S.C., had its longest consecutive period of days (4) over 100°F. in August since 1900. At Minneapolis-St. Paul, Minn., 80°F. on the 22d equalled the highest minimum temperature of record.

The trough near the West Coast continued to bring heavy rains to the Pacific Northwest (fig. 9C). Heavy precipitation also fell in northern portions of the Rockies and Plains States, mostly in association with a deepening storm moving through the area late in the week. Locally severe weather occurred along the front separating cool air in the West and warm air in the East, with tornado activity in Minnesota and Wisconsin early in the week. Precipitation elsewhere was generally light and in much of the Central Plains and Ohio Valley there was none.

#### AUGUST 26-SEPTEMBER 1

A marked readjustment of the circulation occurred between the third and fourth weeks as blocking intensified and the temperate westerlies continued to weaken. The greatest change was in the Atlantic where 700-mb. heights rose as much as 340 m. east of Greenland as the trough there was replaced by a strong blocking High (fig. 9A, 10A). In the United States the High over the Southeast weakened considerably as it retrograded to the Southern Plains and was supplanted by a trough along the coast. At the same time the Pacific Coast trough reversed its tilt from negative to strongly positive and was replaced by a ridge and above normal heights.

This reversal in circulation also brought a sharp change in temperature to much of the Nation. The hot, humid weather in the East was replaced by much cooler and drier conditions as temperatures for the week averaged below normal over the Nation, except for the Far West (fig. 10B). Many daily minimum temperature records were established at stations east of the Mississippi River as average temperatures lowered by as much as 15°F. at some places. By contrast, daily maximum temperature records were set at some cities in the Pacific Coast States where a strong upper High was observed late in the month. It was 98°F. at San Francisco, Calif., on the 29th, 104°F. at Sacramento, Calif., on the 30th, and 102°F. at Medford, Oreg., on the 31st, all daily records.

Precipitation in the West decreased markedly in the last week as anticyclonic flow prevailed (fig. 10C). Heavy rains fell in the Central Plains in connection with the trough there, and also in Florida and southern Georgia in association with a stationary front and tropical depression. Elsewhere in the East, beneath northerly upper flow, precipitation amounts were very light.

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2. Environmental Data Service, ESSA, *Weekly Weather and Crop Bulletin*, Vol. 55, No. 33-37, Aug. 12, 19, 26 and Sept. 2, 9, 1968, pp. 1-8.